

E-education in Refrigeration Technologies for Students and Technicians in the Workplace^{*}

Marnik Lenaerts, Marc Schreurs, Walter Reulens

Limburg Catholic University College (KHLim), Diepenbeek, Belgium

The demand for broadly educated engineers, installers and service technicians is growing because of the strong growth in refrigeration, air conditioning and heating. The rapid technological evolution makes it impossible for a school or training centre to invest in all HVAC (heating ventilation and air conditioning) and refrigeration fields. It is here that e-learning, blended learning and virtual labs provide the answer. Students need new forms of learning where the course materials are available anytime, anywhere and are adapted to the needs and prior knowledge of each individual student. This is the reason why, in 2004, we started with the development of e-learning courses, which are all hosted on an open-source learning management system. Six years later, we have 30 interactive e-learning courses on cooling, heating and air conditioning, ranging from the basics to the latest technologies and systems. We are still developing new ones to keep up-to-date with the latest evolutions. But, education is more than just gaining theoretical knowledge. Our blended learning modules unite the theoretical and the practical aspects of education, by combining e-learning with practical sessions in our labs. Each course participant that uses blended learning does not only benefit from the many advantages of e-learning, but also can gain practical experience in this way. By integrating e-learning in virtual reality, we created virtual labs. We made 3D (3 dimensional) models of our labs complete with installations and equipment using 3D modeling software. Instead of looking at an image of an installation inside the e-learning course, a course participant can now walk around in our labs, walk up to an installation and look at real-time data from the actual installation itself, or go into a virtual classroom and take an e-learning course.

Keywords: e-learning, blended learning, virtual lab, education

Clarification

When in this paper there is spoken of “student”, this means a learner or someone who attends an educational institution either full time or part time as his main occupation. A “technician” is defined as a person who is not a student but comes to an educational institution for the purpose of training. This can be an engineer, installer or service technician. “Course participants” is the collective noun for both students and technicians.

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Marnik Lenaerts, Department of Industrial Sciences and Technologies, Limburg Catholic University College (KHLim).

Marc Schreurs, Department of Industrial Sciences and Technologies, Limburg Catholic University College (KHLim).

Walter Reulens, Department of Industrial Sciences and Technologies, Limburg Catholic University College (KHLim).

E-learning

Education in a school is traditionally done by a teacher who stands in front of a group of students who are attending his/her class. This approach has both advantages and disadvantages. An advantage of this type of education is that there is a direct interaction between the students and the teacher, which makes it possible to quickly address questions and learning problems.

So why change to e-learning? The traditional approach to education targets the course participants as a group, where with e-learning, it is possible to accommodate the wishes and needs of each course participant at an individual level.

What Is E-learning?

E-learning can be defined as a learning method which enables the transfer of knowledge and skills where the course participant can learn anytime anyplace by the use of technology (computers, networks, etc.).

Anytime Anyplace

All that is needed to attend an e-learning course is a computer with an Internet and/or network connection. This makes it a very flexible method of learning.

Traditional education demands that all course participants have to be at a certain place and time to take part in the course. By using e-learning each participant can take the course where he/she wants and when he/she wants. While still be able to contact a teacher or expert for any questions or problems.

Adapted to the Individual

Every course participant has a different amount of prior knowledge and learning pace. This makes it impossible to have one single course that fits everyone perfectly.

With e-learning, it is possible to give every course participant a different learning course that fits to the needs and wishes of the individual.

Because e-learning is done on a computer, it is easy to receive guidance from a teacher or expert. It also let you use social networks, forums, etc., to discuss problems and/or experiences with other course participants.

Stay Up-to-Date

Because all the learning materials are accessed via a computer, there is no need to have handbooks. This does not only save money and paper, but also it makes it very easy to update the e-learning course with the latest technologies and evolutions. As changing a Website is much quicker than reprinting a handbook.

Active Form of Learning

A good e-learning course always makes sure that the course participant plays an active role in the learning process. Interaction between the participant and the course can for instance be done by the use of interactive content.

An e-learning course is not made by just putting plain text on a computer screen and use the advantages of the medium (computer) by enriching the e-learning course, and the learning experience, with moving images, video material, papers, websites, presentations, audio files, (interactive) animations, etc..

Our Experiences

The development of our first e-learning courses started in 2004 to meet the growing demand for broadly educated engineers, installers and service technicians in the fields of refrigeration, air conditioning and heating.

In the beginning, people were a bit hesitant when we introduced them to this form of learning. But soon after they started using e-learning, they saw the benefits of it and were all positive mainly because of the flexibility of it.

Our own studies, surveys and the use of assessment tools show that course participants who use e-learning (with the proper guidance) obtain the same amount of skills and experience in a shorter amount of time than they would, if they were using traditional education.

Software We Use

All the content of our e-learning courses is made in Adobe Flash, as shown in Figures 1 and 2.

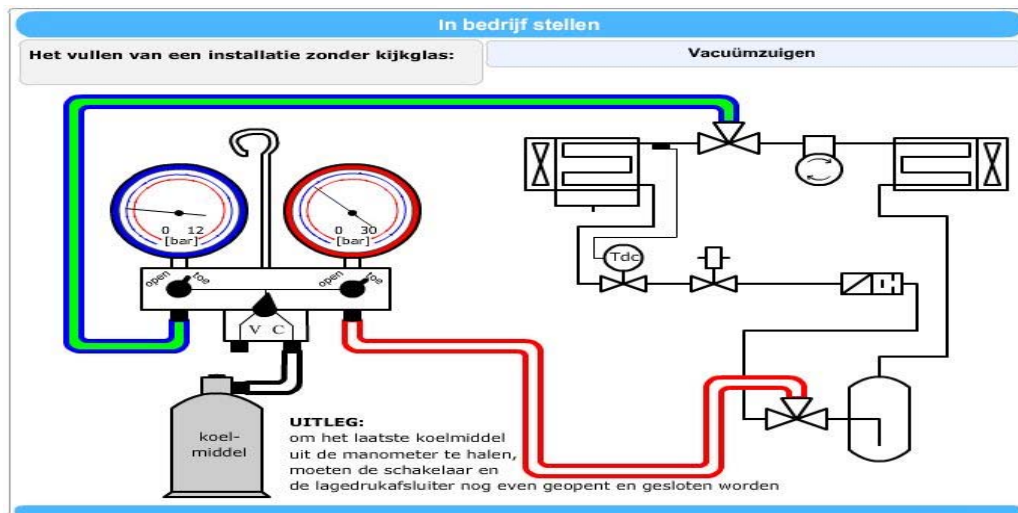


Figure 1. A screenshot of an e-learning page with rich content.

Warmteverlies van een ruimte door transmissie

Het transmissiewarmteverlies Φ_t is de som van de positieve en negatieve warmtestromen door de vlakken die de ruimte begrenzen. Het transmissieverlies is opgebouwd uit warmteverlies naar de buitenlucht, naar aangrenzende, verwarmde of onverwarme ruimtes, naar aangrenzende gebouwen en naar de grond. Deze componenten worden in het vervolg van deze module afzonderlijk besproken. De bijgaande animatie laat de componenten zien waaruit Φ_t is opgebouwd.

Het transmissieverlies Φ_t voor een ruimte wordt berekend met:

$$\Phi_t = (H_{t,ie} + H_{t,ia} + H_{t,io} + H_{t,ib} + H_{t,ig}) \cdot (\theta_i - \theta_e)$$

Ruimteafmetingen

Specifiek warmteverlies naar de grond

Figure 2. A screenshot of an e-learning page with rich content incorporated into the content.

The main advantage of using Flash is that you can insert your rich contents (animations, video materials, etc.) directly with the content of the course. This makes interaction very easy and flexible.

For hosting the e-learning courses, we use Moodle as LMS (learning management system) (learning platform) (Retrieved from <http://moodle.org>). Moodle is an open source and Web-based software application

for the hosting, managing and tracking of e-learning courses.

When the contents of a course are completed, it is wise to convert it to a SCORM-package (Retrieved from <http://www.scorm.com>). SCORM (stands for sharable content object reference model). It is a collection of specifications for e-learning which makes it easy to import the e-learning-course into a learning platform, or transfer it from one learning platform to another.

Blended Learning

To be fully educated means more than just gaining theoretical knowledge. Practical experience is also needed. This is the reason why the development of blended learning modules started.

A blended learning module is a combination of e-learning and specific designed practical sessions in the labs of our school.

E-learning

When a course participant enrolls in a blended learning module, he/she will receive a login to our learning platform. Once logged in via computer, he/she can start learning the theoretical part of the module by means of e-learning, at his/her own time and pace.

Practical Sessions

The course participant is also given a list of dates at which he/she is required to come to our school to participate in the practical part of the blended learning module.

During these practical sessions, each course participant will get hands-on exercises specifically designed to transform his/her theoretical knowledge into practical experience. An example of a practical session is shown in Figure 3.



Figure 3. An example of a practical session.

Virtual Labs

By combining e-learning with 3D (3 dimensional) virtual reality and real-time data, a complete virtual lab

can be build (Retrieved from <http://inet.khlim.be>).

Why

Learning from examples and simulations works good, but nothing is better than being able to work with actual real-time data from actual installations and even be able to manipulate them.

3D Virtual Reality

The first step into building our virtual environment is the creation of lifelike 3D representations of the labs and classrooms in our school. This can be done by using 3D modeling software and a game development tool. Unity 3D is used as engine (Retrieved from <http://unity3d.com>).

But, a lab (virtual or real) is nothing without installations. That is the reason why the next step is to create 3D representations of all the installations, tools, systems, etc., and place them in your virtual environment. Figure 4 shows a photo of the PV (photo voltaic solar panel)-installation and Figure 5 shows the 3D representation of it as use in the virtual lab.



Figure 4. Photo of the PV-installation in our educational institution.



Figure 5. Representation of the PV-installation in the virtual lab.

Real-Time Data

In order to receive real-time data, all the installations need to be equipped with sensors for obtaining data and with control units, if you want to be able to manipulate them.

The last thing that is needed is to build an interface that takes the data from the sensors and makes them

visible in the virtual lab, as shown in Figures 6 and 7.



Figure 6. The interface to view the real-time data.

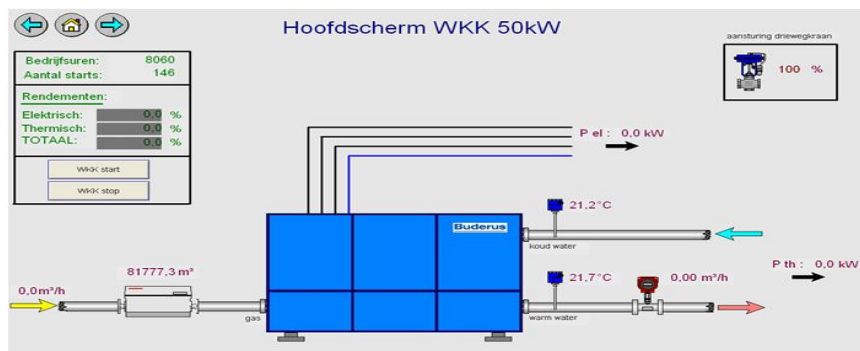


Figure 7. Screenshot of real-time data from our 50 kW CHP (combined heat and power)-installation.

Usage

A course participant can now walk around virtually in our lab looking at the installations and interact with them. For instance, by looking at the real-time data or manipulating them and seeing what influence, it has on the data, without ever having to leave his computer.

Even walking into a (virtual) classroom can be done start or continue an e-learning course.

Conclusions

The possibilities of e-learning, blended learning and virtual labs are endless. They are all parts of a new type of education which can add a totally new dimension to learning. But, do not think that once the content is created that your job as an educational institution is done. A good course (e-learning or in a classroom) needs proper guidance and constant updating.

References

- Example of a virtual lab.* [Online]. Retrieved from <http://inet.khlim.be>
- The Moodle website.* [Online]. Retrieved from <http://moodle.org>
- The scorm website.* [Online]. Retrieved from <http://www.scorm.com>
- The unity3D website.* [Online]. Retrieved from <http://unity3d.com>